Experience Fastback Analysis for Maintenance Optimization at the Stations and Drilling of Brinking Water Supply's Network of Bejaia City

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Abstract

The numerous projects of densification urban tissue of Bejaïa's city will drive in the future to extensions of its Brinking Water Supply's Network. In this situation, will the equipments of EDEMIA Water Company be able to face the continuance of the production process?

The aim of this study is the experience fastback analysis of stations and fields harnessing main equipments of Drinking Water Supply's network of the Bejaia City. We want to estimate their reliabilities, their availability and as a consequence, those of the various modes network functioning. It is a question of determining an optimal politics of maintenance on the basic of an economic study.

1. Introduction.

Modern technologies allow us to list and to exploit in best the few resources hydrique that we have. Indeed, Algeria is in one of the poor zones in hydraulic resources. Where from the importance of a good exploitation and a good management of this indispensable resource. A good management suggests obviously an adequate plan of maintenance of the equipments, based on the concepts of reliability, of maintenability and availability.

The fast extension of the population of the Bejaïa's city leads difficulties in the drinkable water supply. At present, the EDEMIA Water Company manages to assure certain degree of satisfaction of the population's necessities. It will become more difficult with the new extensions of the network and seen the different abnormalities which knows the Drinking Water Supply's Network of Béjaïa's city (repeated cuts of water, considerable flights,…). Where from the necessity of a rigorous management allowing to reduce these abnormalities, by assuring a continuance in the process of production, by the introduction of procedures capable of optimizing the equipments' exploitation of the network, to raise their availability.

2. Maintenance within the EDEMIA and data collection.

The EDEMIA administers six sectors of Bejaïa's Wilaya, regrouping 13 municipalities. Until 31.12.01, it feeds more than 320.000 inhabitants.

The service maintenance of the EDEMIA Company assures preservation in state of functioning of 31 drillings and (05) wells equipped with groups electropumps immersed (GEPI), and 46 stations of transfer equipped with groups electropumps horizontal (GEPH).

To reconstitute our samples, we were forced to confront several sources: The cards of interventions, the checks of exit stock, the reports of production, and it, for period spreading for 01. 01. 1995 to 30. 09.2001.

3. Modeling and appraisal of network's reliability.

The drinkable water supply of Bejaïa's city makes from the drillings of Oued Zitouna and Oued Agrioune, Oued Djemaa's wells, as well as from Kherrata's source the produced water arrives at the central station situated to Oued Sghir. Of this last one, arise three chains of expulsion ("Ancient city",

"Sidi-Ahmed", "Ihaddaden"), allowing the food of it almost totality of the city. According to the topography (hilly landscape) of Bejaïa's city, food makes by floors.

The study of reliability is going to base itself on the main constituents of drillings, wells and network's stations, which are going to represent the diagram's blocks of the system's reliability. Where drillings, well and source forms, of the point of view reliability, a system 12/12, which is mass with the central station and under system representing distributive network. This last one constitutes a system 3/3 (three directions) of the point of view reliability.

Before proceeding to the model of the network, we made a classification of the groups electropumps according to their technical characteristics.

According to the quantity of water produced with the fields of harnessing, the network works according to four modes for climatic reasons. From the global system, approach consists so in estimating the reliability of variants characterizing the various modes of it functioning.
The diagrams 1 represent the most frequent case of functioning of the system.

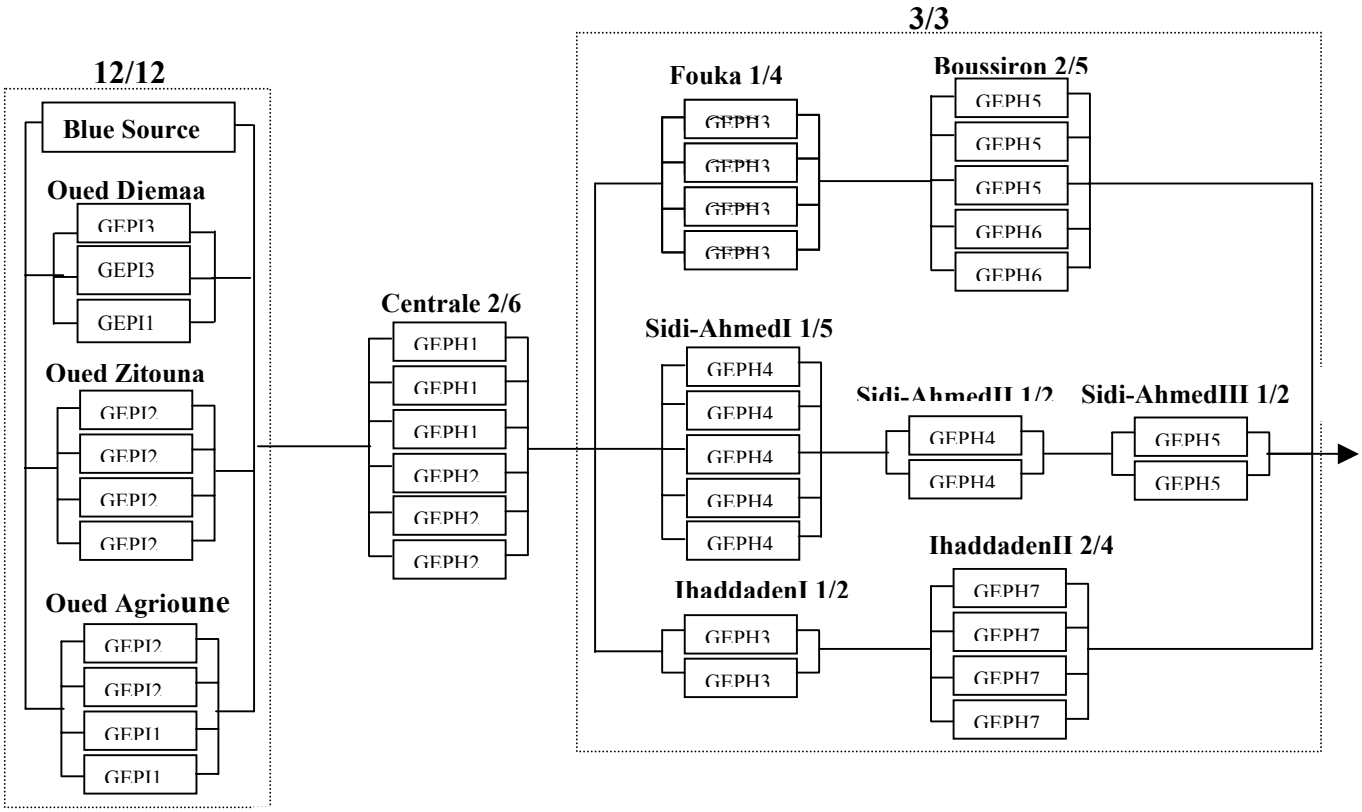

Diagram 1. Diagram of the most frequent variant 2 reliability

4. Analysis of the groups electropumps' reliability.

In this part of the study, we modeled the laws of survivals of the system's constituents, from the data of the times of good functioning of the electropumps groups' classes raised from the experience fastback.

We made for that purpose, two types of modeling:

- A modeling by non parametric distributions (IFR, DFR) confirmed by the test of Prochan-Pyke and by the graphic test.
- A modeling by Weibull's law in two parameters. Confirmed by the test of Khi-deux and by the test of Kolmogorov-Smirnov.

4.1. Non-parametric modeling

The results obtained by the graphic test for the set of the classes are given in the following tables:

Table 1. Graphic test results for the classes of GEPH

GEPH	n	Speed	Model
GEPH1	66	Concave	IFR
GEPH2	78	Concave	IFR
GEPH3	94	Concave	IFR

Table 2. Graphic test results for the classes of GEPI

GEPI	n	Speed	Model
GEPI1	73	Straight	Exponential
GEPI2	29	Convex	DFR
GEPI3	45	Straight	Exponential

These results are confirmed by the Proschan-Pyke test.

4.2. Parametric modeling

The estimation of the parameters is done by the least squares procedure, which brings in at the same moment the TBF and the function of empirical survival. This last one estimated by Kaplain-Meier's method for complete data [2].

Table 3. Adjustment results of laws for the GEPH's classes

GEPH	Adjusted laws	Parameters		MUT (hours)
GEPH1	Weibull	$\beta = 1.70$	$\eta = 1927$	1719.26
GEPH2	Weibull	$\beta = 1.54$	$\eta = 2027$	1823.08
GEPH3	Weibull	$\beta = 2.04$	$\eta = 1452$	1286.70
GEPH7	Exponential	$\lambda = 0.00056536$		1768.78

Table 4. Adjustment results of laws for the GEPI's classes

GEPI	Adjusted laws	Parameters		MUT (hours)
GEPI1	Weibull	$\beta = 1.32$	$\eta = 3664$	3356.16
GEPI2	Exponential	$\lambda = 0.000270738$		3693.60
GEPI3	Exponential	$\lambda = 0.000223773$		4468.80

This results reveals, on one part that the majority of the groups electropumps pump stations are subject to failings wear. On the other part, it reveals that the groups electropumps fields of harnessings are subject to unpredictable failings.

The reliability curves of groups electropumps classes and those of the different variants of the system are shown above.

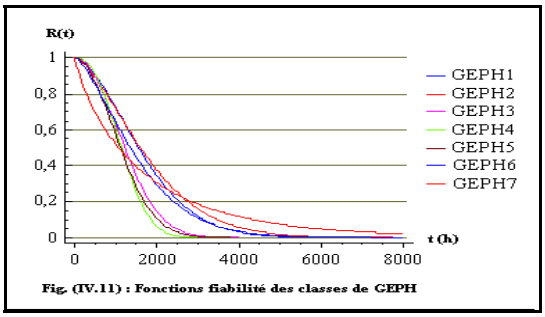

Fig.1. Reliability function of GEPH's

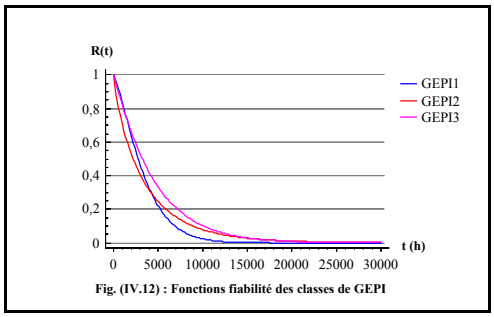

Fig.2. Reliability function of GEPH's class

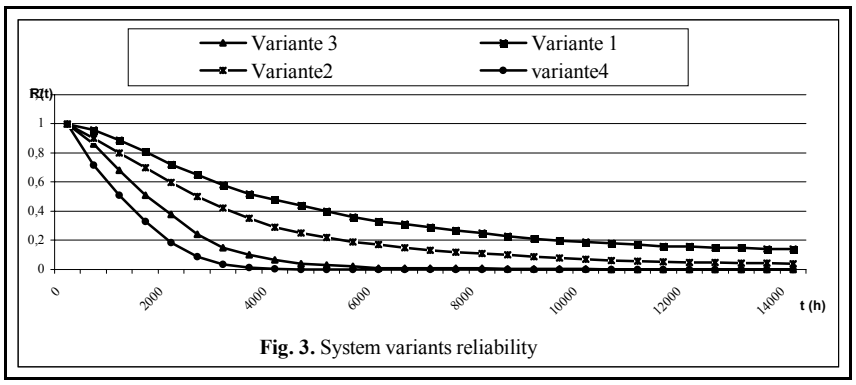

Fig. 3. System variants reliability

An economical renewal study, on the GEP which present an increasing rate of failing, is realised. It showed that the report of the cost of failing on the cost of the renewal is sharply lower than 1. What drives to conclude that preventive renewal is not economically advisable. That explain by the fact that the cost of the cubic meter of water is very weak in front of the replacement's cost of the failing element.

5. Availability study.

The objective of this part of study is to know the factors that influence this availability, among the reliability, the maintenability and the logistics of maintenance. To do it, we have first to estimate the laws of maintenability and the pauses of the various classes of groups electropumps. One estimated the availability of these last ones, in the first place by taking into account times annex in the repair, noted D1. Secondly, one let us consider only the times of repair, noted D2. So, one was able to estimate unavailability pulled by times annex in the repair (D2 - D1). Obtained results are put back in the following table:

Table 5. Availability of the network's GEP

GEP	MUT	MTTR	MDT	D_1	D_2	D_2-D_1
GEPH1	1719.26	17.55	75.18	0.958	0.990	0.032
GEPH2	1823.08	17.72	75.94	0.960	0.990	0.030
GEPH3	1286.70	16.49	117.98	0.916	0.987	0.071
GEPI1	3355.20	35.07	103.77	0.970	0.990	0.020
GEPI2	3693.60	30.62	114.23	0.970	0.992	0.022
GEPI3	4468.80	31.91	186.20	0.960	0.993	0.033

Table 6. Availability for system's variants

	Variant 1	Variant 2	Variant 3	Variant 4
Availability rate	0.905	0.894	0.792	0.775
Availability (hours)	158.4	6656.7	832.5	67.42

One notices according to the obtained results that the groups electropumps of drillings and central station present unavailability's rate caused by times annex to the repair, relatively weak with regard to those groups electropumps of the other network's stations. This explains itself by the importance of the impact over the return on the network in case of breakdown at the level of drillings or of central station, what drives service maintenance to take care of them first and foremost.

6. Conclusion.

This study will allow the EDEMIA Water Company to estimate reliability and availability of the network by envisaging other modes of functioning, notably in the case of increase of the network's exploitation. It will also allow a help in making decision to raise the network's availability by the practice of redundancy on the least reliable infrastructures, or by setting up a better management of repairs.

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